國立中興大學機械工程研究所

碩士論文

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單缸二行程引擎循環變異與排氣分析量測

Analysis and Measurements of the Cyclic Variations and the Emissions of Single Cylinder Two-Stroke Engines

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摘 要

單缸二行程引擎由於其特殊的曲軸箱驅氣方式，造成其在低負載時容易發生循環變異現象，並產生大量的污染排放，在空污法規日益嚴格的今天，便限制了二行程引擎的發展。但二行程引擎具有構造簡單、單位重量較便宜、與高功率等優點，故若能了解其循環變異現象發生的原因與找出降低排氣污染的方法，便仍有其發展空間。

本研究爲利用傳統引擎模擬分析程式，以能量平衡的觀點發展點火成功條件，替代以殘留氣體比例爲條件的簡單模式，並發展三區可調式驅氣模式，而建立一可用的曲軸箱驅氣式單缸二行程引擎循環模式。並利用該模式，改變不同的參數，模擬引擎的運轉狀況，探討空燃當量比、火燄傳播速度、輸送比、與驅氣模式對循環變異與排氣成分濃度的影響，並與實驗量測值做比較分析。

計算結果顯示，當量比在1.1時，火燄移動速度最快，燃燒最好，循環變異現象最嚴重，而當量比爲1.0時，HC排放濃度最低；火燄移動速度愈快，燃燒狀況愈好，殘留氣比例愈大，間隔燃燒周期變多，HC排放濃度變低；輸送比增加，驅氣效率提高，循環變異變小，甚至消失，HC排放濃度因進氣量大小與燃燒狀況而變，CO排放濃度則因燃燒狀況與熄火循環數而定；驅氣效率愈差的驅氣模式，其循環變異現象愈嚴重，而熄火循環數愈多的驅氣模式，其HC排放濃度愈高，CO排放濃度愈低。本研究並發現不論是何種驅氣模式，都可能找到一組參數，使系統發生混沌現象。由實驗數值顯示，本循環分析模式能夠掌握引擎在低負載運轉時的循環變異現象，以及對其排氣污染的影響趨勢。

ABSTRACT

The cyclic variations of single-cylinder two-stroke engines is very serious and the emission is very high at low load condition because of the special scavenging process. The development of the two-stroke engine is bounded due to the increasing strict Air Pollution Control Act, although there are many advantages of the two-stroke engines, such as its simple-construction, and high-power. But, if we can understand the source of its cyclic variation and emission in detail, there is wider room to develop for the two-stroke engine.

In this paper, we establish the cycle model of a single cylinder two-stroke engine of crankcase scavenging type, which misfire model is base on energy balance instead of the residual gas fraction and scavenging model is adjustable three-zone model. We use the cycle model to simulate the low condition, and study how the cyclic variation and the emission are under the influence of the model parameters. Also, we experiment on a commercialized motor engine, and measure some experiment data to compared with the results of the simulation.

The results of simulation show that the combustion condition is the best on when its equivalence ratio is 1.1, but the phenomenon of cyclic variation is most serious. The HC emission is the least on when its equivalence ratio is 1.0, and increases with the number of the uncompleted combustion cycle, but the CO emission is opposed to it. The more residual gas following the better combustion situation with increasing the flame propagating speed makes the phenomenon of skip combustion serious and the HC emission lower. If the delivery ratio increases, the scavenging efficiency increases and the cyclic variation is reduced. Concurrently, the HC emission is affected by the quantity of the intake fuel-air-mixed gas and the combustion situation; and the CO emission is affected by the combustion situation and the number of misfire cycle. The scavenging model with the worst scavenging efficiency make the phenomenon of the cyclic variation serious; the scavenging model with the more number of misfire cycle makes the HC emission higher but makes the CO emission lower. If we change the model parameters, it is possible to get the chaotic process no matter which scavenging model we choose.

Results of calculation were compared with measured data at low load engine conditions. The misfire rate and the short circuit ratio agree well with experimental data. The trends of variation for HC and CO emissions while equivalence ratio was varied are in consistent with the measured data. However, the magnitudes of calculated emission are about 30% higher than the measured data.

目 錄